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Extraordinary Economic and Social Events Associated with the Solar Cycle Maximum

The currently unfolding solar cycle 25 reached its maximum on or about October 2024. According to long-standing theoretical claims, cyclical maximums of solar activity could be associated with economic recessions (W.S.Jevons), revolutions and migration (A.L.Chizhevsky). And indeed, several of such extraordinary events have already occurred recently. These include revolutions in Bangladesh (2024), government collapse in Syria (2024), Hamas terrorist attack on Israel (2023), and student protests in the US and Europe against the war in Palestine (2024). Meanwhile, migrant influx overwhelmed the US and Western Europe. Are we going to see more of the extraordinary events typically associated with the solar maximums, such as revolutions in a few more countries colliding in a revolutionary wave like the Arab Spring of 2010-12 or collapse of Communism in 1989-91? Or economic recessions in the US and other advanced economies leading to a global economic slowdown?

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What are the Solar Cycles and Solar Maximums?

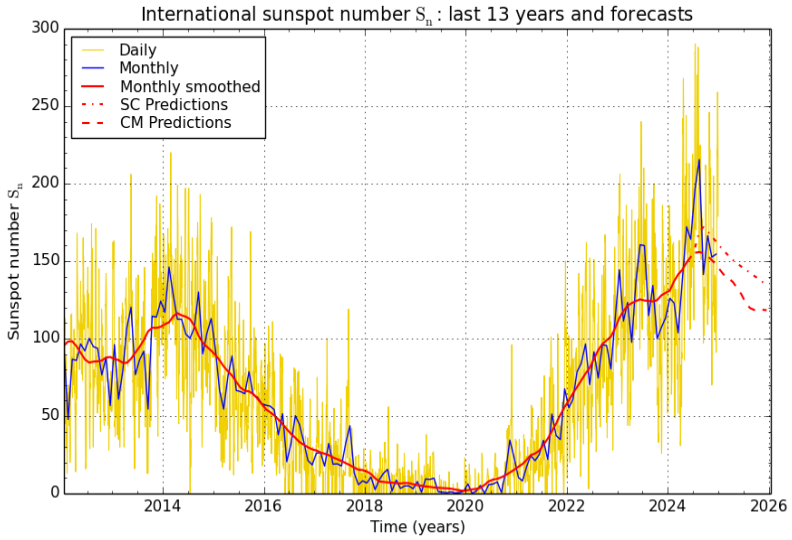
The solar cycle refers to the periodic changes in the Sun's activity and appearance, including variations in the number of sunspots, solar flares, and coronal mass ejections. It lasts approximately 11 years on average and is driven by changes in the Sun's magnetic field.

The solar cycle is tracked by counting sunspots and monitoring solar emissions. Sunspots are temporary phenomena on the Sun's surface that appear visibly as dark spots compared to surrounding regions. They are caused by intense magnetic activity that inhibits convection and forms areas of reduced surface temperature.

Solar maximum occurs in the period of most intensive solar activity when sunspots are most numerous. Solar minimum refers to a cyclical period of low solar activity when the sunspots are few or completely absent. In addition to the sunspot number, which remains the primary measure of solar activity, many other indicators have been established and recorded, particularly in recent years. They include the indicators of radio activity, radiance, proton emission, solar wind, solar flares, and coronal mass ejections (CME).

The cycles are numbered since mid-XVIII century, with the first numbered cycle running from the minimum in 1755 to the next minimum in 1766. Currently, solar cycle 25 is unfolding from a minimum in December 2019 through the cyclical maximum on or about October 2024 toward the next minimum expected in about 2030 (Figure 1). The current cycle 25 has turned out much stronger than originally predicted, but still weaker than many strong cycles of the XX century (Annex I).

Figure 1. Solar Activity and Predictions, 2012-26



Theoretical Claims about Possible Impact on Economy and Society

Famous British economist and statistician William Stanley Jevons developed the theory explaining the period of the trade cycle with variations in solar activity. In Jevons' lifetime, "commercial crises" occurred at intervals of 10-11 years (1825, 1836-39, 1847, 1857, 1866), which broadly matched the average solar cycle length. In his papers, Jevons carried back this history of "commercial crises" at 10-11-year intervals almost to the beginning of the XVIII century. This "beautiful coincidence," as he called it, produced in him a strong conviction of causal nexus, going from cyclical solar activity through crop-harvest fluctuations to commercial trade cycles (Jevons 1875, 1878, 1879, 1882).

Russian scientist Alexander Chizhevsky advanced a theory suggesting that the solar activity cycles shaped all human history. His thinking was influenced by the striking observation that two Russian revolutions of the early XX century (in 1905-07 and 1917) and several major European revolutions of the XIX century (e.g., in 1830, 1848, and 1871) occurred in the years of maximum solar activity. Chizhevsky scrutinized the available sunspot records and solar observations comparing them to riots, revolutions, battles, and wars in Russia and 71 other countries for the period from 500 B.C. to 1922. He found that a significant percent of revolutions and what he classified as "the most important historical events" involving "large numbers of people" occurred in the 3-year periods around sunspot maximums.

Chizhevsky proposed to divide the eleven-year solar cycle into four phases: (1) a 3-year period of minimum activity (around the solar minimum) characterized by passivity and "autocratic rule"; (2) a 2-year period during which people "begin to organize" under new leaders and "one theme"; (3) a 3-year period (around the solar maximum) of "maximum excitability," revolutions and migration; (4) a 3-year period of gradual decrease in "excitability," until people are "apathetic." Through his subsequent studies, Chizhevsky came to believe that correlations with the solar cycles could be found for a very diverse set of natural phenomena and human activities. In one of his books, he compiled a list of as many as 27 of them, ranging from crop harvests to epidemic diseases and mortality rates (Chizhevsky 1924, 1938, 1976).

Modern Research Corroborating Long-standing Theoretical Claims

Even though the exact reasons of it remain unclear, economic recessions in the US and other advanced economies do occur more often around cyclical maximums of solar activity (Gorbanev 2012, 2015, 2020). In the US, where the longest series of consistent recession dates is available, during the entire XX century and in the early XXI century each cyclical maximum of solar activity overlapped closely with a recession. This striking pattern worked for over 100 years until the US economy did not go into recession after the maximum of the weak solar cycle 24 in April 2014 (Figure 2).

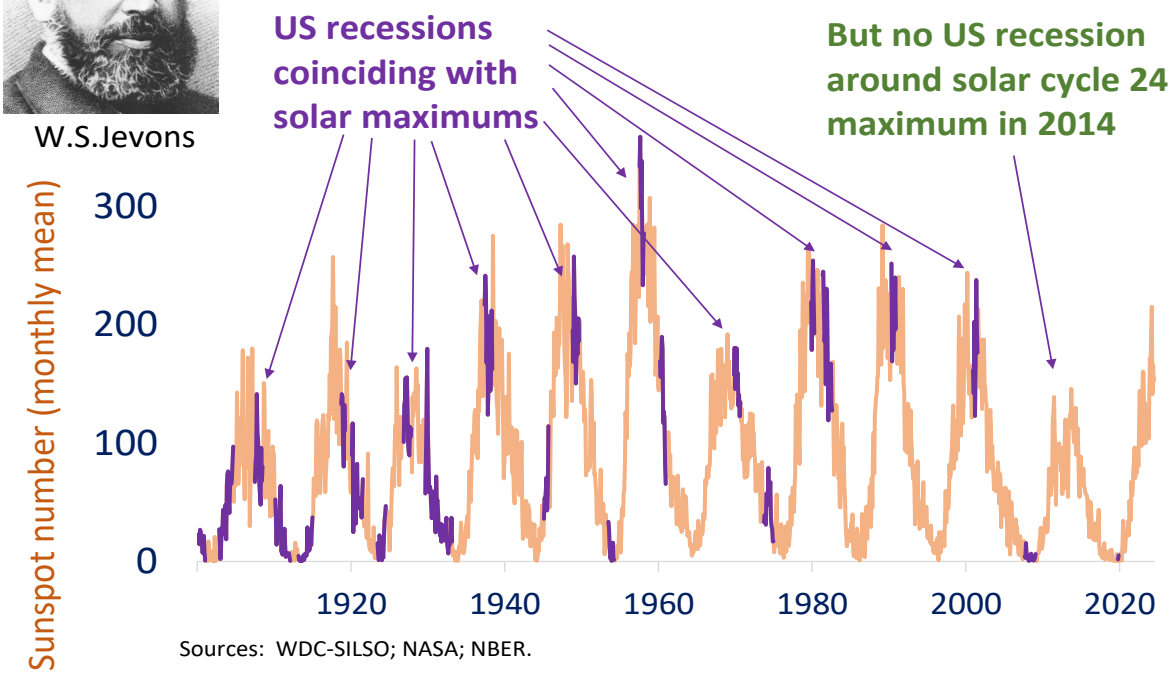
Solar cycles could be linked with various other economic indicators, from the US GDP, interest rates and inflation to fluctuations of oil and metal prices (e.g., Belkin 2018, 2023, 2024, 2025).

Major revolutions that change the course of history also occur more often around maximums of solar activity (e.g., Gorbanev 2020; Hernandez and Zilli Vieira 2023). Solar cycle maximums provided milestones for the advent and demise of communism in Europe, from Paris Commune in 1871 (maximum of solar cycle 11) to the first and second Russian revolutions (maximums of solar cycles 14 and 15) to the ultimate collapse of the USSR and the Soviet bloc in 1989-91 (maximum of solar cycle 22). Most recent revolution wave named “Arab Spring” also overlapped closely with maximum of solar cycle 24 (Figures 3-5).

Besides, there is a growing body of literature on the solar activity influence on human health and behavior. Geomagnetic disturbances driven by solar activity can increase cardiovascular mortality risks, with the number of cases of myocardial infarction increasing during geomagnetic storms (Zilli Vieira et al. 2019; Gurfinkel and Breus 2014). Solar flares can be associated with higher rates of heart failures (e.g., Mahayni et al. 2024). Solar-driven geomagnetic disturbances can influence homicide rates in various countries (e.g., Behrens et al. 2024; Otsu 2006).

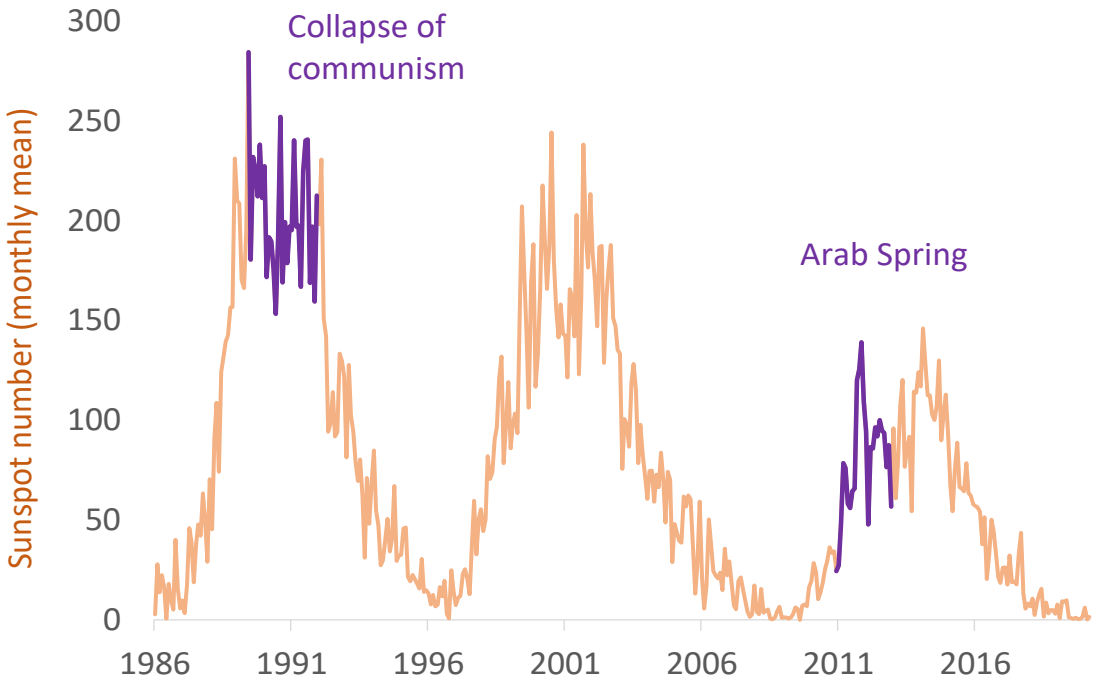
W.S.Jevons

Figure 2. Solar Cycles and US Recessions, 1900-2024



Sources: WDC-SILSO; NASA; NBER.

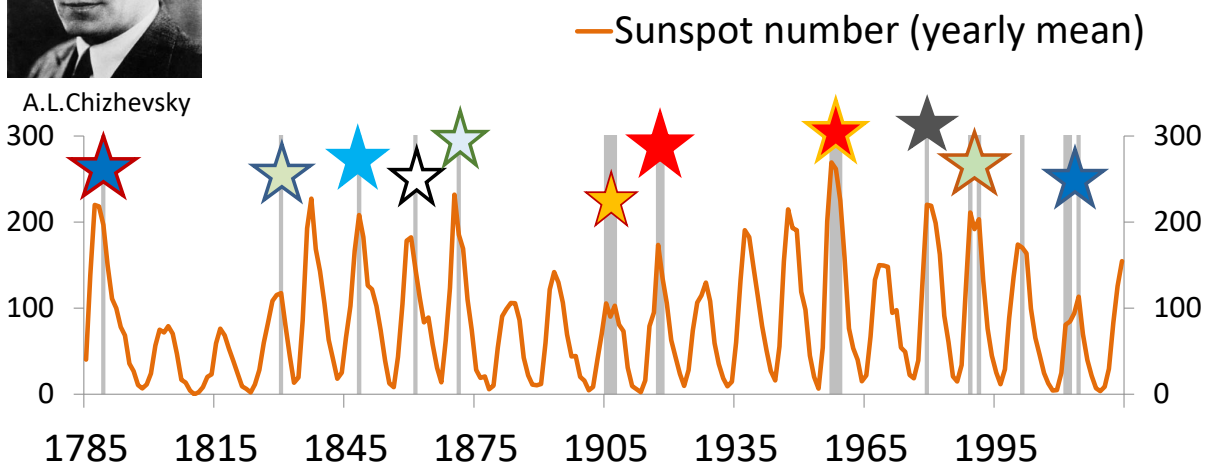
Figure 3. Two Most Recent Revolutionary Waves



Sources: WDC-SILSO; history textbooks.

A.L.Chizhevsky

Figure 4. Selected Revolutions that Overlapped with Solar Maximums, 1785-2024

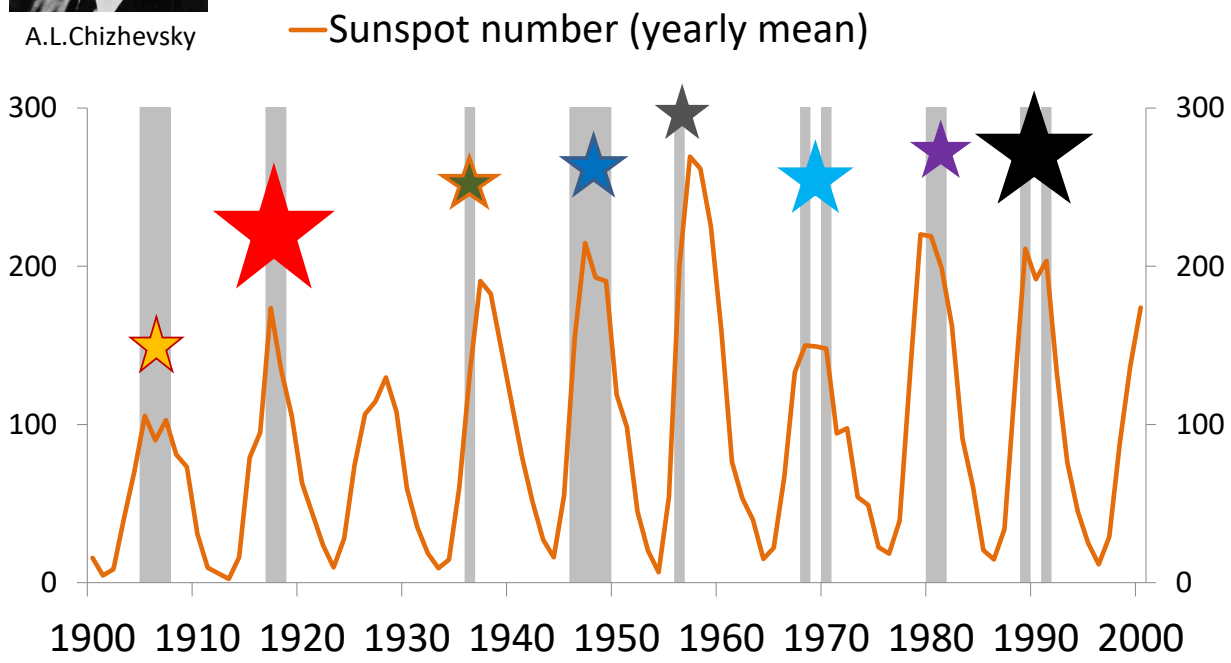


	Years	Events
	1789	Great French Revolution
	1830	Revolutions in Europe (France, Poland, Germany, Italy, Greece)
	1848	Revolutions in Europe (Italy, France, Germany, Austria, etc.)
	1861	Secession of 13 southern US states that formed the C.S.A.
	1871	Uprising in Paris "Paris Commune"
	1905-07	Revolution of 1905-07 in the Russian Empire
	1917 1918	February Revolution, Great October Socialist Revolution in Russia Revolution in Germany, collapse of the Austro-Hungarian Empire
	1957-59	Revolution in Cuba
	1979	Islamic Revolution in Iran
	1989 1991	Fall of Berlin Wall, collapse of communism in Eastern Europe Collapse of Soviet Union and Yugoslavia
	2010-12 2013-14	"Arab Spring": Revolutions in Egypt, Libya, Syria, Yemen, Tunisia, etc. Revolution in Ukraine

Sources: WDC-SILSO; NASA; history textbooks.

A.L.Chizhevsky

Figure 5. Advent and Demise of Communism in Europe in XX Century



	Years	Events
★	1905-07	Revolution of 1905-07 in the Russian Empire
★	1917 1918	February Revolution, Great October Socialist Revolution in Russia Revolutions in Germany, Hungary, collapse of Austro-Hungarian Empire
★	1936	Revolution in Spain
★	1946-49	Conversion of Eastern Europe to socialism
★	1956	Hungarian revolution, Poznań protests in Poland
★	1968 1970	"Prague Spring" in Czechoslovakia Protests in Poland
★	1980-81	Polish crisis, "Solidarity" trade union, martial law
★	1989 1991	Fall of Berlin Wall, collapse of communism in Eastern Europe Collapse of Soviet Union and Yugoslavia

Extraordinary Events Associated with the Maximum of the Solar Cycle 25

Several extraordinary events—revolutions, social unrest, and terrorist attacks—have already occurred in the run up to the solar maximum recorded on or around October 2024. All of them have clear parallels with the events of similar types that occurred around maximums of solar activity in the past.

Terrorist Attack on Israel

Hamas terrorist attack on Israel on October 7, 2023 resulted in nearly 1,200 civilian casualties and taking of 251 innocent people hostage. It was the deadliest terrorist attack of its kind in the modern history of Israel. In Israel and elsewhere it has been referred to as "their 9/11" for its comparison with the terrorist attack of al-Qaeda against the U.S. committed on September 11, 2001.[2] The comparisons rightfully focused on the magnitude of civil casualties (which was much larger for Israel than for the US when measured as percent of population), taking of hostages, shocking social and political impact, and subsequent actions by the national governments.

However, most if not all conventional analysis missed that both events occurred amid the backdrop of elevated solar activity. The 9/11 attack on the US occurred just two months before the cyclical maximum of the solar cycle 23 recorded in November 2001. And the 10/7 attack on Israel occurred about a year before the cyclical maximum of the solar cycle 25 recorded on or about October 2024 (Figure 6).

The 10/7 attack provoked the war between Hamas and Israel that claimed up to 50,000 lives and brought about massive destruction and human sufferings in Gaza. This war spread to the entire region, with the subsequent wars and conflicts between Israel and Hezbollah, Yemen's Houthis, and Iran. This was very similar to the US response to the 9/11 attack.

After the 9/11 attack, the US government declared a global war on terror. In October 2001 US-led coalition invaded Afghanistan to dismantle Al-Qaeda and apprehend the attack's mastermind

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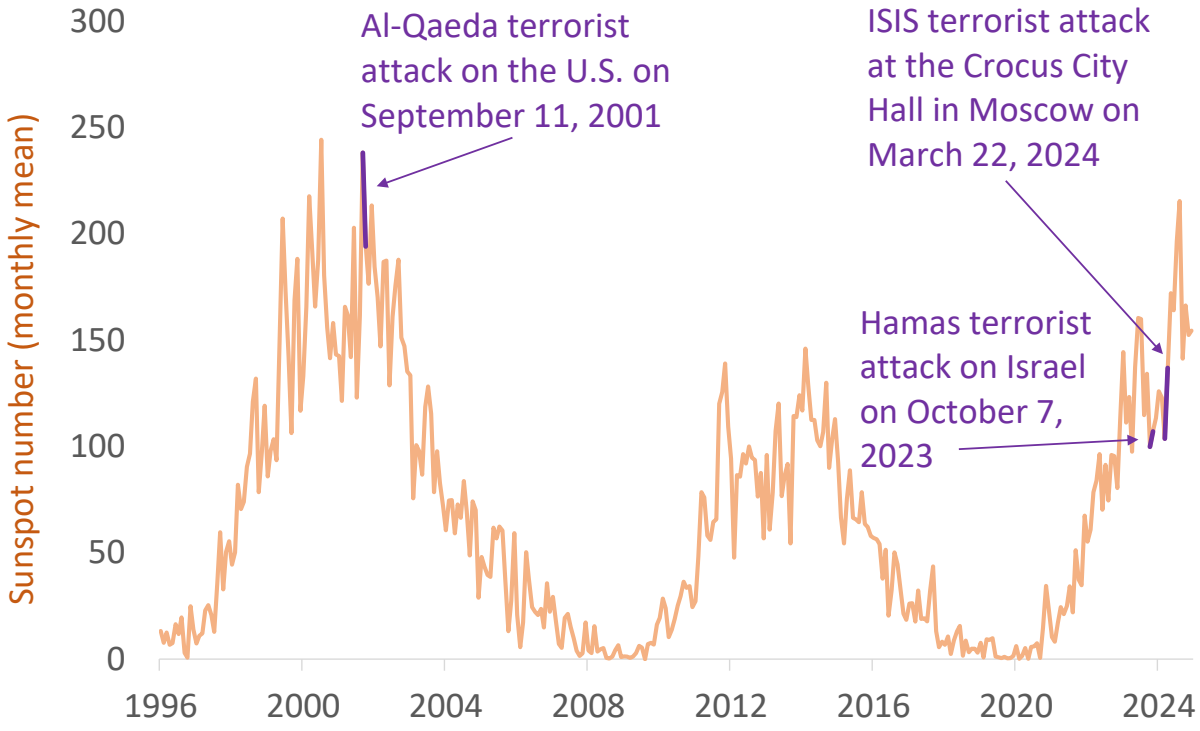
[2] For example, Why 10/7 Was Worse for Israel Than 9/11 Was for America, Comparing Hamas' attack on Israel and 9/11 - A Counterterrorism Perspective, and even Why the Oct. 7 Attack Wasn't Israel's 9/11.

Osama bin Laden. In October 2023, another US-led coalition invaded Iraq under the pretext that Saddam Hussein's regime possessed weapons of mass destruction and had ties to terrorist groups, even though neither of it could be eventually proven.

In addition, let's remember the terrorist attack at the Crocus City Hall in Moscow on March 22, 2024 perpetrated by an ISIS-affiliated group that left 145 people dead and more than 551 injured. It confirmed that the increase in terrorist activities associated with the maximum of solar cycle 25 was not limited to the Middle East.

Figure 6. Major Terrorist Attacks, 1996-2024



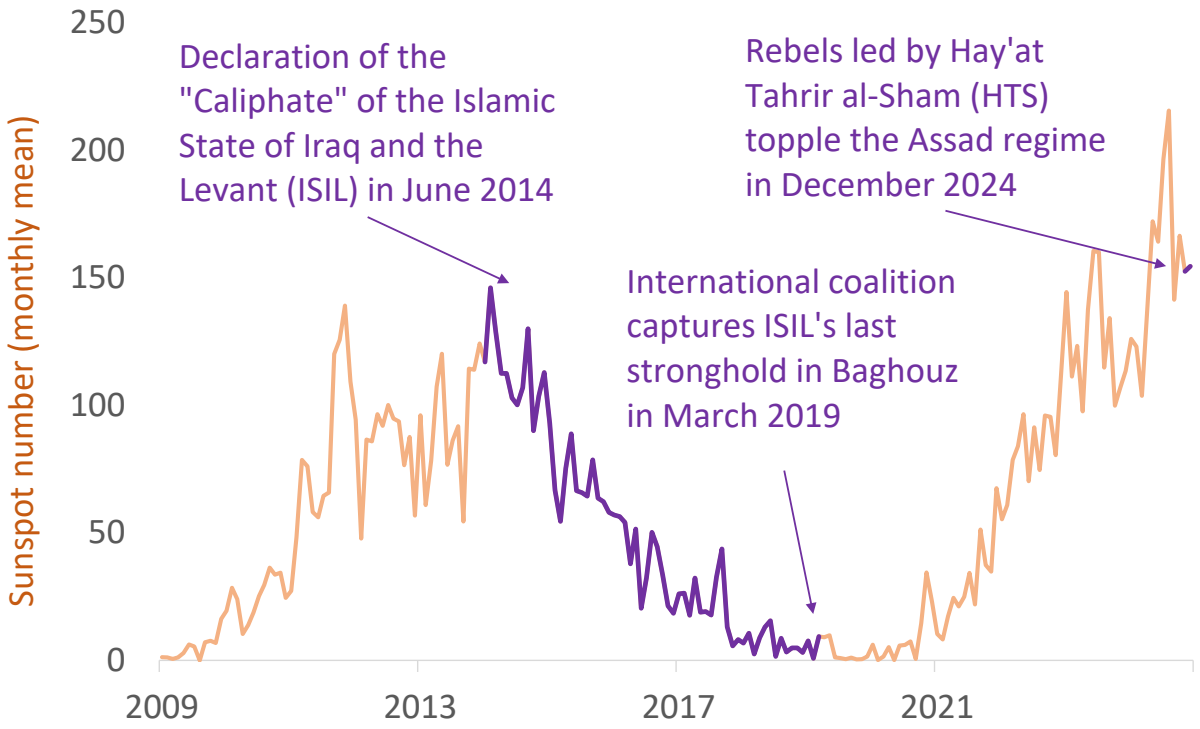
Sources: WDC-SILSO; News reports.

Assad Regime Collapse in Syria

In December 2024, the Assad regime collapsed after a major offensive of the rebel coalition led by Hay'at Tahrir al-Sham (HTS) and supported by other groups such as the Turkish-backed Free Syrian Army (FSA). The swift fall of the Assad's regime—that retained power against all odds during the 13-year civil war that began in 2011—surprised many observers around the world and the Syrian people themselves.

It remains to be seen whether the rebel coalition that took power in Syria builds a modern prosperous state or serves as a grim reminder of the Islamic State of Iraq and the Levant (ISIL). ISIL gained prominence in 2014 amid the maximum of the previous solar cycle 24, when its militants conquered large territories in northwestern Iraq and eastern Syria where they enforced their extremist interpretation of Islamic law. By the end of 2015, its self-declared caliphate ruled an area with a population of about 12 million, managed an annual budget exceeding US$1 billion, and commanded more than 30,000 fighters. It required a wide international coalition including Iraqi, Syrian, Kurdish, Russian, and US forces to defeat ISIS. By March 2019, ISIS lost all its territories in the Middle East, although its affiliates maintained a significant territorial presence in Africa (Figure 7).

Figure 7. Regime Changes in Syria, 2009-24



Sources: WDC-SILSO; News reports.

Student Protests

Human casualties and suffering associated with the Hamas-Israel war in Palestine prompted massive student protests in the US and Europe. Pro-Palestinian protests on university campuses

began in late 2023 and escalated in April 2024 (the year of solar maximum) with events such as the Columbia University campus occupation. As of early May 2024, student protests have occurred in 45 out of 50 US states, with encampments, occupations, walkouts, or sit-ins on almost 140 campuses. Eventually, student protests have taken place in more than 25 countries. About thirty encampments were established in the UK, Australia, and Canada. The protests paused with the end of the academic year in June but then resumed in September 2024, albeit with less scope and intensity.

The protesters' main demands included discontinuation of military and financial support to Israel and severing financial ties and partnerships with Israeli institutions. These pro-Palestinian student protests of 2024 did not stop U.S. governmental support for Israel. However, they eventually contributed to a gradual shift of sentiments in the US and European capitals away from supporting Israel and towards a more neutral position in the war. In the US, it manifested in delays of Congress approval of support packages for Israel. In Europe, Norway, Ireland, Spain, and Slovenia recognized Palestine in May-June 2024, amid the peak of student protests. In November 2024, the International Criminal Court issued arrest warrants for Israeli PM Netanyahu and former Defense Minister Yoav Gallant accusing them of war crimes in the context of war against Hamas.

The student protests of 2024 were almost immediately compared with anti-Vietnam war student protests of 1968 (the year of solar cycle 20 maximum, which was recorded in November 1968).[3] One striking similarity was that US Columbia University was in the epicenter of student protests both in 1968 and 2024 (Annex II). For example, the student protesters occupied the same building (Hamilton Hall) in Columbia University in 2024 as they did in 1968. In both years, the student protests influenced the results of the US Presidential elections where a Republican candidate defeated Democratic incumbent. President Nixon who assumed office in 1969 at first escalated American war efforts but then took steps towards ending the war in Vietnam that culminate in the US troops withdrawal in 1973. President Trump who assumed office in January

[3] For example, In Columbia University's protests of 1968 and 2024, what's similar — and different, Columbia Student Protesters Occupied The Same Building In 1968—Here's How The Two Protests Compare So Far, The Brief – 1968, 2024: Students continuing the fight?

2025 campaigned on the promises to end regional conflicts and reduce US involvement in them, although his success in delivering on these promises remains to be seen.

Revolution in Bangladesh

The revolution in Bangladesh occurred in August 2024, the month with the highest single-month sunspot count so far in the current solar cycle 25 and just two months before the officially announce cyclical maximum of solar activity in October 2024 (which is defined by the smoothed 13-month average of monthly sunspot observations).

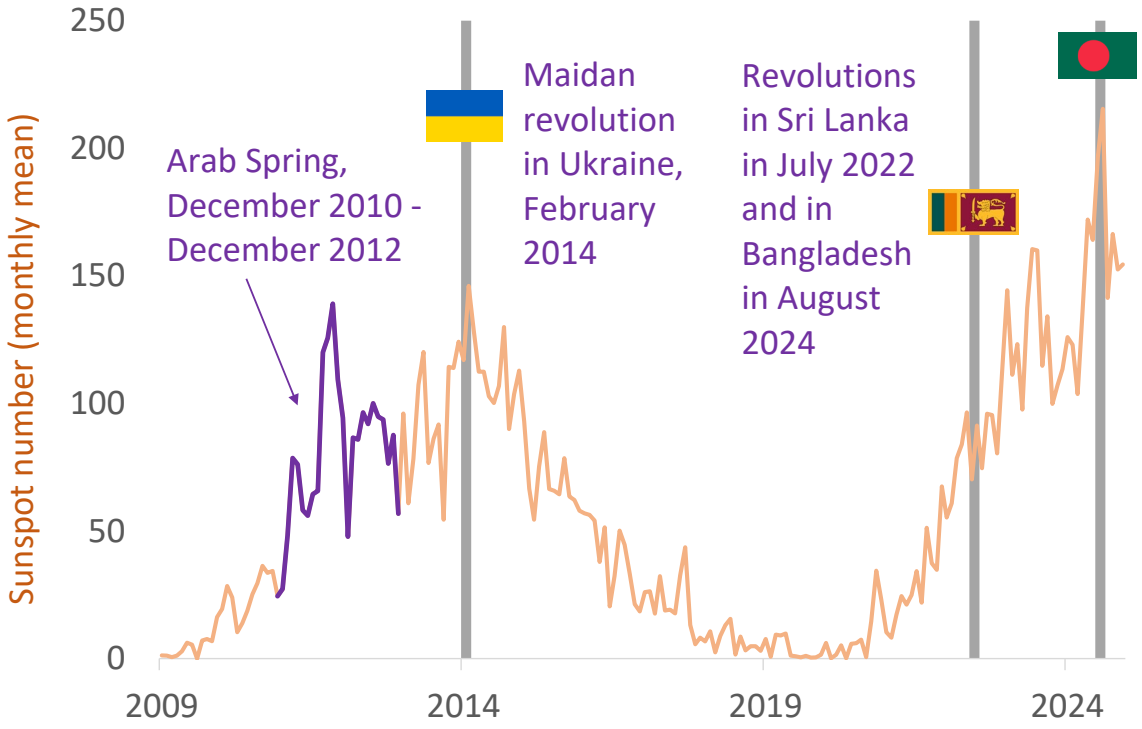
As the revolution in Bangladesh occurred just two years after the similar revolution in the neighboring Sri Lanka, it immediately prompted comparisons with the Arab Spring, the revolutionary wave that unfolded in 2010-12 and overlapped closely with the cyclical maximum of solar activity in the previous solar cycle 24.[4] It remains to be seen whether the revolutions in Sri Lanka and Bangladesh will be followed by revolutionary events elsewhere in the region, where several countries appear to be prone to them (e.g., Pakistan, Nepal, Bhutan, Myanmar, Maldives).

But given the timing of the Bangladesh revolution within the solar cycle, it also should be compared with the revolution in Ukraine (Figure 8). The Maidan revolution in Ukraine triumphed in February 2014, the month with the highest sunspot count in the solar cycle and just two months ahead of the official maximum of the solar cycle 24 recorded in April 2014. One of the main causes of the Ukrainian revolution was people's disappointment with policies of integration with Russia pursued by the government of V. Yanukovych (who escaped to Russia after the revolution) and desires to end energy and economic dependence on Russia and integrate into the European Union instead. In the same way, Bangladesh economic and energy dependence on India played a significant role in fueling social discontent that contributed to the August 2024 revolution. The deposed Bangladesh PM Sheikh Hasina escaped to India after the revolution.

[4] For example, Does the Uprising in Bangladesh have Similarities with Arab Spring?, Will Bangladesh's Revolution Go the Way of Arab Spring?, Arab Spring Effect in South Asia: After Sri Lanka and Bangladesh, Which Next?

In the aftermath of the revolution in Ukraine, the Russian authorities accused the new Ukrainian authorities of violating the rights of their Russian-speaking population. Russian authorities used it as a pretext to annex Crimea and support separatist movement in Donbass in 2014, and, eventually, for military invasion of Ukraine in 2022. Shortly after the revolution in Bangladesh, the Indian authorities accused the new Bangladesh ruling authorities of violating the rights of their Hindu population and other religious minorities.

Figure 8. Revolutionary Activity, 2009-24



Sources: WDC-SILSO; history textbooks; news reports.

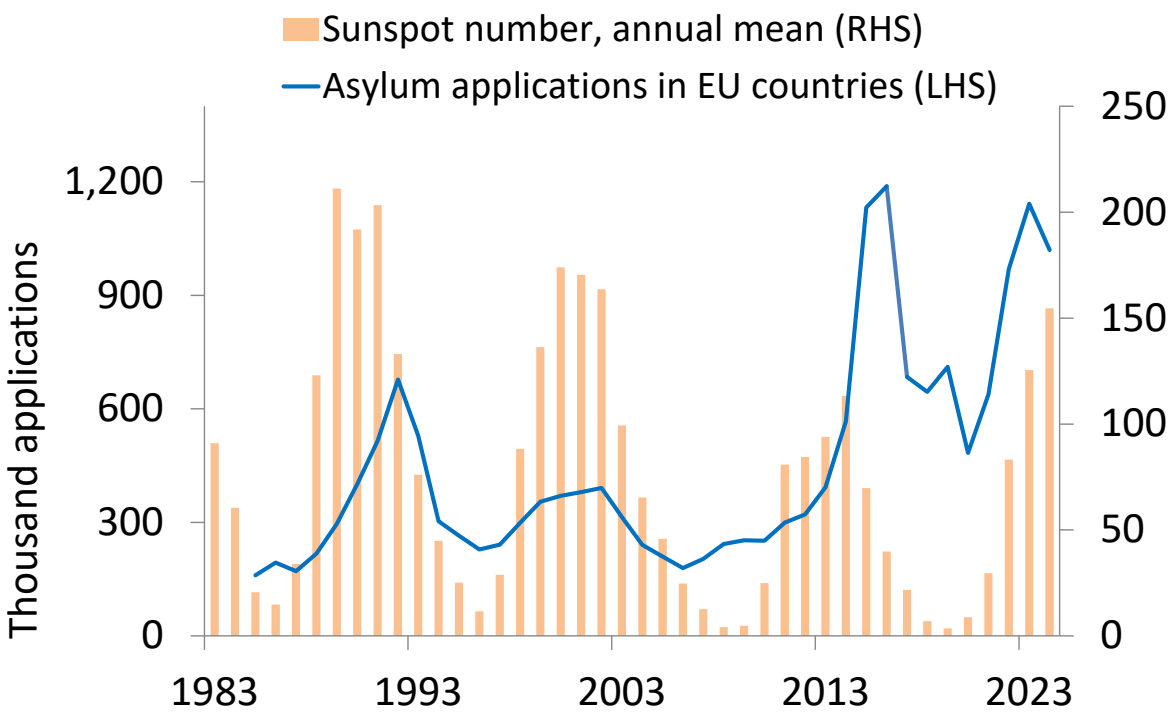
Mass Migration

As Russian scientist A. Chizhevsky discovered many years ago, solar maximums could be associated with increased mass migration of people triggered by revolutions and other social and geopolitical upheavals. And indeed, challenges posed by mass migration have become top concerns in both the US and Europe in recent years. The governments' capacity to handle migration has become the key factors in elections, including D.Trump victory in the US presidential election in November 2024 (which almost coincided with the official solar cycle

maximum in October). In Europe, the ability to solve migration challenges has become top political concern in the UK, France, Germany and other countries.

Migration influx into Europe surged as the solar cycle 25 progressed towards its maximum recorded in late 2024. The same surges in migration were observed near the maximums of previous solar cycles (Figure 9).

Figure 9. Sunspots and Asylum Applications in the EU, 1983-2024

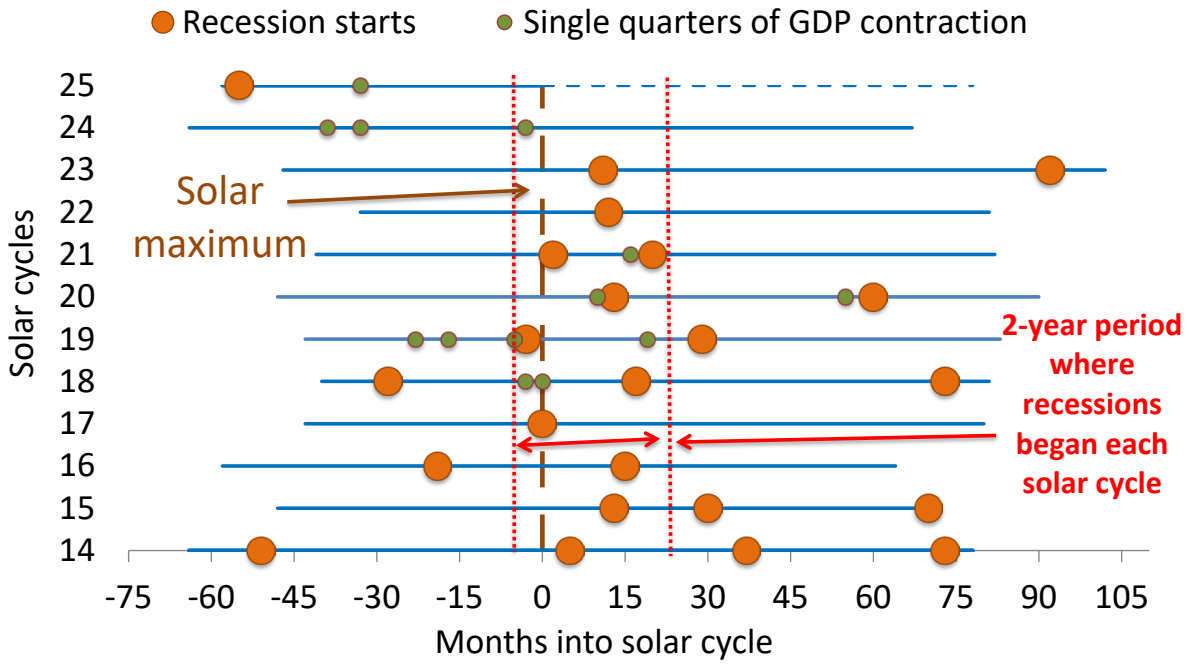


Sources: Eurostat; UK Government; WDC-SILSO; and author's calculations. Consolidated data for 14 EU countries and UK reporting numbers for all years.

Economic Recessions

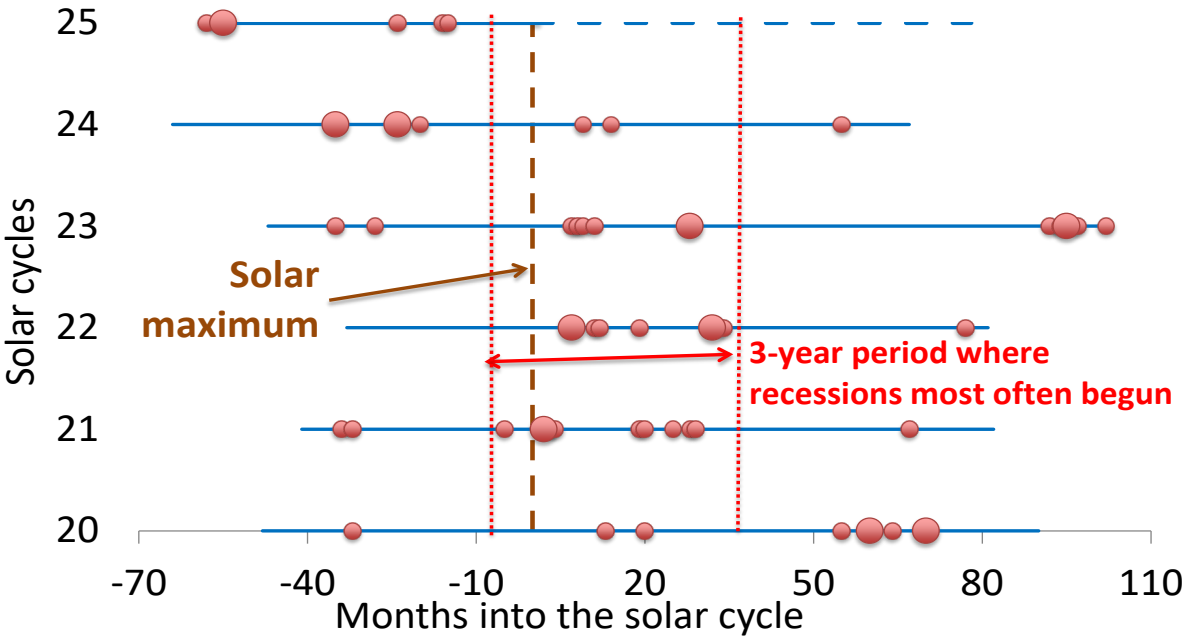
As indicated by previous research, recessions in the US economy are most likely to occur in about two years around the solar maximums. Recessions in G7 economies—which includes Canada, France, Germany, Italy, Japan, the UK and the US—can also occur within approximately 3 years around and after cyclical maximums of solar activity (Gorbanev 2012, 2015). Moreover, these recessions can overlap and amplify each other, causing a global economic slowdown (e.g., Belkin 2024). As of September 2024 (the last monthly data point available for all G7 countries), none of the G7 economies were in recession (Figures 10-11).

Figure 10. US Recession Starts in 1901-2024
(Solar cycles 14-25 centered on solar maximums)



Sources: NBER; FRED; NASA; and author's calculations.

Figure 11. G7 Recession Starts in 1965-2024
(Solar cycles 20-25 centered on solar maximums. Larger markers for months when recessions began in two or more countries.)



Source: NBER; ECRI; NASA; and author's calculations.

While the US economy is growing at a steady pace and not considered in or close to recession now, there have been several warning signs recently indicating that the next economic recession may be closer than some people think. For example, in the summer of 2024 worsening of the labor market indicators prompted concerns about imminent recession. At that time, the little-known Sahm Rule triggered warning signs of possible recession. The Sahm rule is triggered when the three-month moving average of the unemployment rate increases by 0.5 percentage points or more relative to its low in the previous 12 months (e.g., Michaillat and Saez, 2024). In late 2024, US credit card and auto loans default rates soared to multi-year highs.[5] Their recent readings became comparable to the elevated levels recorded during previous US recessions. This suggests that the US and other G7 economies should be watched closely for the signs of economic recessions, which can manifest in 2025 or 2026.

Conclusions

According to long-standing theoretical claims, cyclical maximums of solar activity could be associated with economic recessions, revolutions, and other forms of social and economic upheavals. This paper scrutinized the extraordinary events of this type that could be associated with the solar maximum of the currently unfolding solar cycle 25, which reached its maximum on or about October 2024. Most notably, these include revolution in Bangladesh (2024), government collapse in Syria (2024), Hamas terrorist attack on Israel (2023), student protests in the US and Europe against the war in Palestine (2023-24), and migrant influx overwhelming the US and Western Europe. For each event, we identified comparable historical events that occurred around maximums of solar activity in the previous solar cycles. Moreover, we pointed out rising probability of economic recession in the US in the two years around and after solar maximum as well as in other G7 economies in about 3 years around and after the solar maximum. In case these recessions overlap and amplify each other, they can cause a global economic slowdown in 2025-26.

[5] For example, "US credit card defaults jump to highest level since 2010," "Is the surge in US auto loan defaults to 15-year highs a reason to panic?"

Literature references

Belkin, Vladimir, 2018: “Cycles of Oil (1970–2017), Metals (1980–2017) Price and the Eleven–Year Solar Cycle: Statistics of Strong Relations,” — Chelyabinsk Humanist, № 1 (42) / January 2018, pages 83-89. Available at SSRN.

Belkin, Vladimir, 2023: “U.S. Federal Reserve Rate and Solar Activity (1955-2022): Proof of Strong Correlations,” — March 17, 2023. Available at SSRN.

Belkin, Vladimir, 2024: “Ordinal Numbers of Years of Solar Cycles (1960-2022) and Gross World Product with a Lag of 1 Year (1961-2023): Evidence of Very Strong Correlations.” — DOI 10.13140/RG.2.2.18377.76647/6. Available at ResearchGate.net.

Belkin, Vladimir, 2025: “US CPI and Geomagnetic Index Ap: Proof of a Strong Relationship (1932-2024).” – January 16, 2025. Available at SSRN.

Behrens, Alfredo, Beltrão, Kaizô, Clz, Vieira, Almeida, D. 2024: “The Impact of Space Weather on Social Dynamics: Homicide Trends in Canada and the USA,” — Acta Neurophysiol, June 2024, Volume 5, Issue 2: 180061. Available at ResearchGate.net.

Chizhevsky, Alexander, 1924: "Physical Factors of the Historical Process," — Kaluga, 1924. (In Russian: А.Чижевский. Физические факторы исторического процесса. — Калуга, 1-я Гостиполитография, 1924).

Chizhevsky, Alexander, 1938: “Les Epidemies et les perturbations electro-magnetiques du milieu exterieur,” — Paris, Hippocrate, 1938.

Chizhevsky, Alexander, 1976: “The Terrestrial Echo of Solar Storms,” — Moscow, “Thought”, 1976 (In Russian: А.Л.Чижевский. Земное эхо солнечных бурь. — Москва, Издательство «Мысль», 1976.)

Gorbanev, Mikhail, 2012: “Sunspots, unemployment, and recessions, or Can the solar activity cycle shape the business cycle?” — MPRA Paper, No. 40271, July 2012.

Gorbanev, Mikhail, 2015: “Can solar activity influence the occurrence of economic recessions?” — MPRA Paper, No. 65502, July 2015.

Gorbanev, Mikhail, 2020: “Shifting Pattern of Extraordinary Economic and Social Events in Relation to the Solar Cycle” — MPRA Paper, No. 102163, July 2020.

Gurfinkel, Yury; Breus, Tamara, 2014: “What are the evidences of solar activity influence on coronary heart disease?” — 40th COSPAR Scientific Assembly. Held 2-10 August 2014, in Moscow, Russia, Abstract id. F5.5-14-14. Abstract available at Harvard.edu.

Hernandez, Andreas; Zilli Vieira, Carolina Leticia, 2023: “Does the sun catalyze and shape cycles of revolutions and social protest?” — abstract available at Harvard.edu.

Jevons, William Stanley, 1875: “Influence of the Sun-Spot Period on the Price of Corn,” — A paper read at the meeting of the British Association, Bristol, 1875.

Jevons, William Stanley, 1878: “Commercial crises and sun-spots,” — “Nature,” Volume xix, November 14, 1878, pp. 33-37.

Jevons, William Stanley, 1879: “Sun-Spots and Commercial Crises,” — “Nature,” Volume xix, April 24, 1879, pp. 588-590.

Jevons, William Stanley, 1882: “The Solar-Commercial Cycle,” — “Nature,” Volume xxvi, July 6, 1882, pp. 226-228.

Mahayni, A, A. Sularz, G. Russo, H. Alarouri, and M. Alkhouli, 2024: “Solar Danger: Solar Flares are Associated with Higher Rates of Heart Failure-Related Hospitalizations and Deaths.” — Journal of the American College of Cardiology, April 2024, Volume 83, Issue 13, Supplement, page 705.

Michaillat, Pascal, and Emmanuel Saez, 2024. "Has the Recession Started?" — Papers 2408.05856, arXiv.org, revised Sep 2024. Available at RePec.org.

Otsu A, Chinami M, Morgenthale S, Kaneko Y, Fujita D, Shirakawa T., 2006: “Correlations for number of sunspots, unemployment rate, and suicide mortality in Japan,” — Perceptual and Motor Skills, Apr 2006; 102(2):603-8. doi: 10.2466/pms.102.2.603-608. PMID: 16826682. Available at https://pubmed.ncbi.nlm.nih.gov/16826682/.

Zilli Vieira CL, Alvares D, Blomberg A, Schwartz J, Coull B, Huang S, Koutrakis P., 2019: “Geomagnetic disturbances driven by solar activity enhance total and cardiovascular mortality risk in 263 U.S. cities.” — Environ Health. 2019 Sep 11;18(1):83. doi: 10.1186/s12940-019-0516-0. PMID: 31511079; PMCID: PMC6739933.

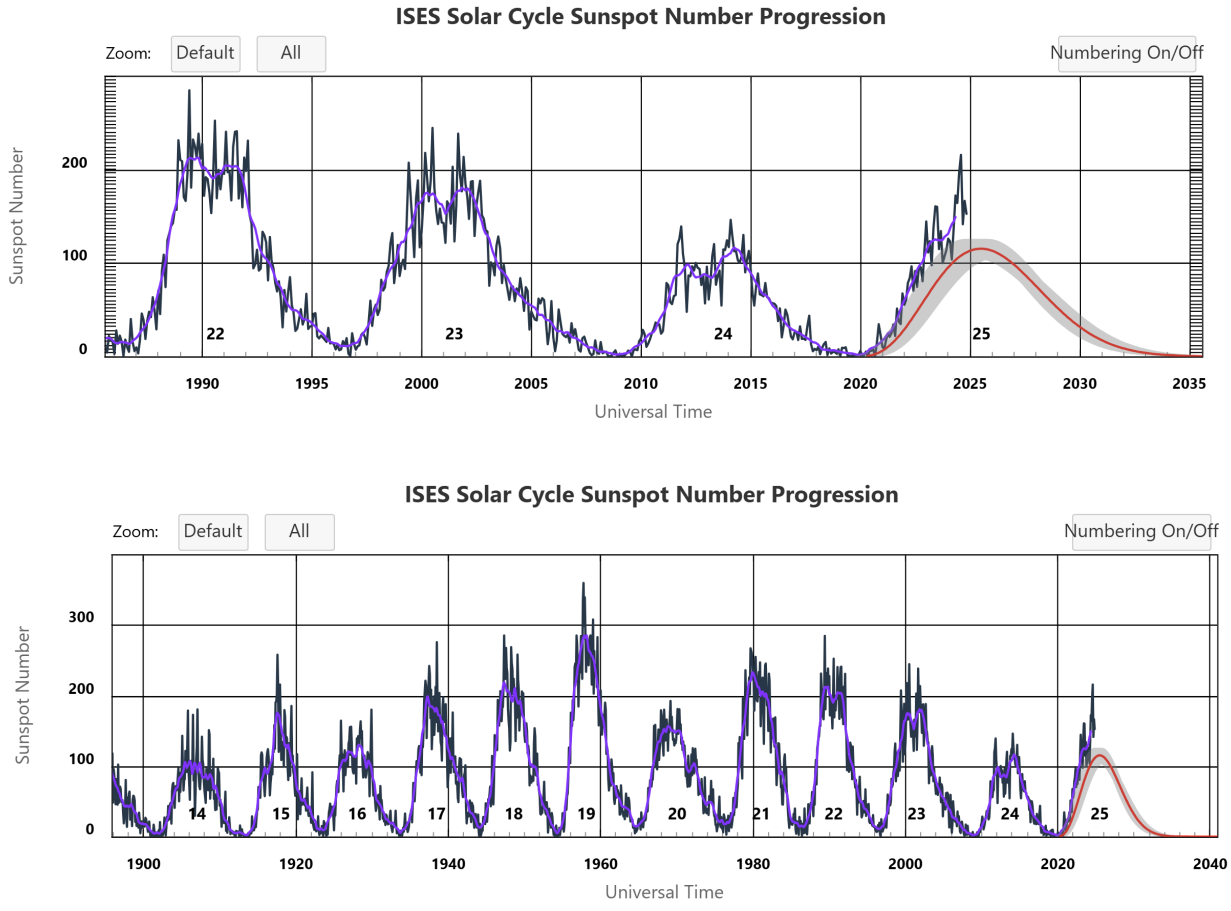
Methods. The results reported in the article are derived from comparing data series for sunspots with dates of US recessions, most important revolutions, terrorist attacks, and social unrest.

Data availability statement. The data that support the findings of this study are publicly available from WDC-SILSO, Royal Observatory of Belgium, Brussels; US National Aeronautics and Space Administration (NASA); US National Bureau of Economic Research (NBER); history textbooks; news reports; and Wikipedia. Further information on the data that support the findings of this study are available from the author upon request.

Annex I. Solar Cycle Predictions and Progression

The currently unfolding solar cycle 25 has turned out much stronger than originally predicted, but still weaker than many strong cycles of the XX century.

According to early predictions, the solar cycle 25 was expected to broadly match the magnitude of the previous solar cycle 24, which was the weakest cycle in almost 100 years. The official forecast for the solar cycle 25 came from the Solar Cycle Prediction Panel representing NOAA, NASA, and the International Space Environmental Services (ISES) that was convened in 2019. The Panel predicted cycle 25 to reach a maximum of 115—as measured by the smoothed monthly value (13-month average) of sunspot observations—in July 2025. This was very close to the smoothed monthly value of 116.4 recorded at the maximum of the previous cycle 24 (reached in April 2014), which was the weakest since cycle 14 in the early XX century.



Source: NOAA Space Weather Prediction Center, https://www.swpc.noaa.gov/products/solar-cycle-progression.

However, cycle 25 has significantly surpassed early predictions. The officially calculated smoothed monthly value exceeded 150 by mid-2024 and holds the potential for further upside surprises. The highest single-month sunspot number recorded so far in the cycle 25 was 215.5 in August 2024. This made cycle 25 broadly comparable—but still weaker—than some strong solar cycles observed in the XX century. It remains to be seen whether this high monthly sunspot number was a one-off record (and the solar cycle will subside as predicted), or a harbinger of strong solar activity in the coming months.

Annex II. Protests at Columbia University: 1968 vs. 2024

The Columbia University protests of both 1968 and 2024 were significant moments of student activism, with the former focusing on civil rights and antiwar issues and the latter on free speech and U.S. foreign policy in the Israel-Hamas conflict.

The 1968 protests were fueled by opposition to the Vietnam War, Columbia's discriminatory construction plans in Harlem, and ties to defense research. The 2024 protests arose from tensions over the Israel-Hamas conflict, accusations of stifling pro-Palestinian voices, and debates over free speech. In 1968, students occupied buildings, prompting a violent NYPD response and leading to the cancellation of the gym project and reforms in university governance. In 2024, protests included rallies and social media campaigns, with heightened campus security and legal scrutiny over free speech concerns. Both events highlighted generational demands for justice. The 1968 protests influenced civil rights and antiwar movements. The 2024 protests reflected shifting perspectives on U.S. foreign policy and Middle East politics amidst growing campus polarization. While occurring in differing historical contexts, they had many similarities.

	1968 protests	**2024 protests**
Protesters on Day 1	300	More than 100
Police were called in on:	Day 7	Day 2
Key protest groups	**Society of Afro-American Students** (SAS) **Students for a Democratic Society** (SDS)	**Gaza Solidarity Encampment** 2 campus groups, **Students for Justice in Palestine** and **Jewish Voices for Peace,** were suspended in November 2023
Occupied property	5 buildings including Hamilton Hall and Low Library	Hamilton Hall
Hostages taken	1 (Dean Henry Coleman held in his office for 25.5 hours)	none
Number arrested in crackdown	712, with 148 injuries reported (April 30, 1968)	At least 108; no injuries reported (April 18, 2024)
Main target(s) of protest	Columbia's plan for a gym in Harlem's Morningside Park The Vietnam War School's role in the Institute for Defense Analyses	The war in Gaza Demands for the university to divest from companies that profit from the war and/or do business in Israel
Related issues	Discrimination and inequality targeting Black people and women	Antisemitism and free speech
School president	Grayson Kirk	Minouche Shafik

Source: Columbia University Libraries, and NPR reporting.